Report to MAC on Magnets

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LBNL

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Recommendations from Oct '01 MAC

- Implement proposed upgrade of stability measurement systems
- Perform estimate on radiation damage tolerances allowed by NLC spec for each permanent magnet design
- Consider reducing the number of alternative designs
- Some effort should be devoted to determining if vibrations from LCW can be maintained with in specifications
- When a PM design meets NLC specs has been identified its cost for construction, installation and operation should be compared to an EM

Implement proposed upgrade of stability Measurement Systems

- Due to budget cap there is no money to upgrade the Fermilab system at this time
- SLAC has moved the rotating coil system to a small room from the high bay of the light assembly building. Improved temperature and humidity control
- Both SLAC and FNAL systems are adequate for current needs

Perform estimate on radiation damage tolerances allowed by NLC spec for each PM design

- Still gathering information on expected radiation levels in Main LINAC and Damping Rings.
- Old Measurements from SLC and damping rings inconsistent due to assumptions and calculations So these data are little use to NLC.
- Have been doing measurements in SLC damping ring distinguish different types of particles
- Radiation levels do vary by orders of magnitudes and types depending on location. Need to get better models.
- Different types of radiation have different effects on Permanent Magnets.

Radiation Damage Testing

- First dipole is in FNAL shop expect to build 5-10 dipoles to test various aspects of magnets aging, different radiation fields, different manufacturers
- Have in hand 100 Hitachi ND-Iron magnets to start tests
- Have a space at FNAL LINAC to expose dipoles to 400 MeV neutrons and protons
- Need to find other sources of particles
- Looking for help from University groups
  - An Ideal project for a small group!

Consider Reducing the Number of Alternative Designs

- Corner tuner has been eliminated
- Work on the sliding shunt and counter rotating quads has stopped due to budget cap
- New rod tuning mechanism for wedge tuner has been built center stability is encouraging
- Computer models of Wedge and Ring Quad are proceeding
- There is still time to explore models before ‘04

Wedge Quad Rod Turning Mechanism

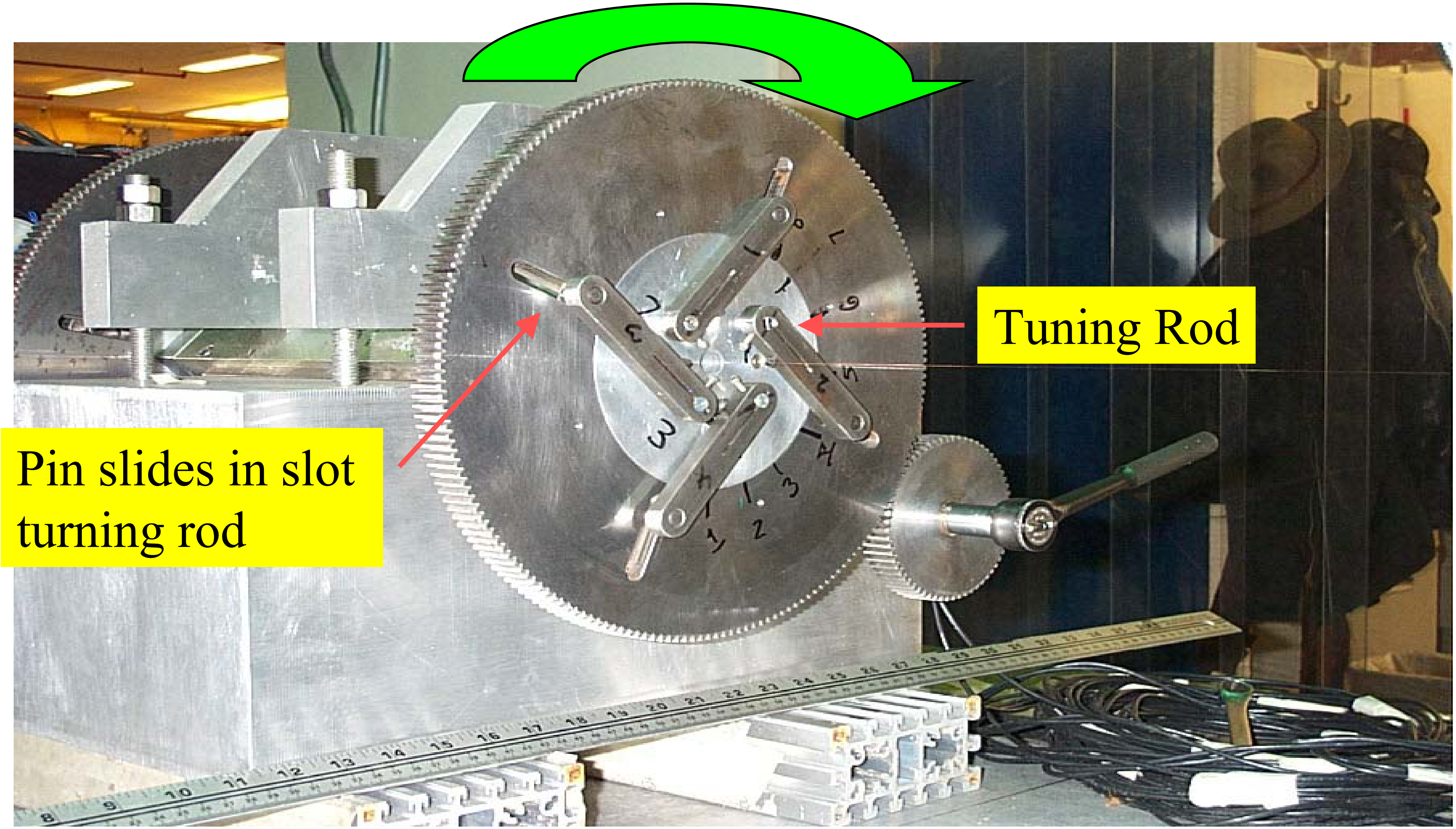
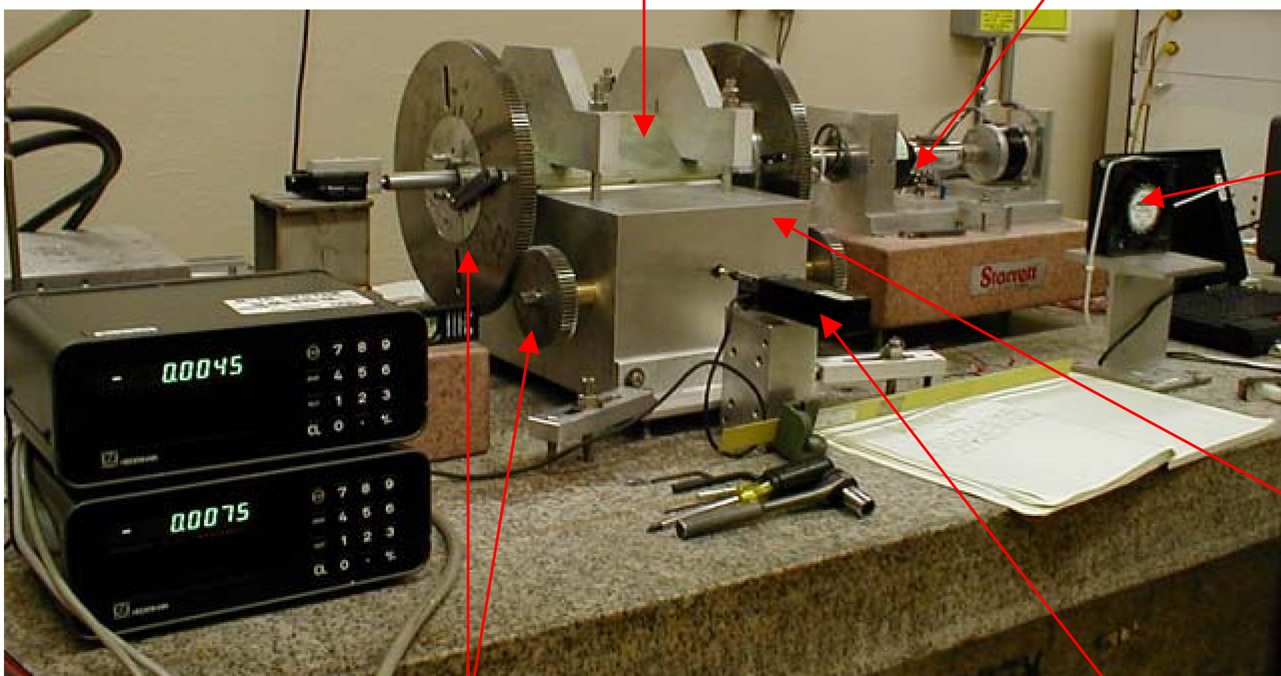


Photo of the Wedge Quad on the SLAC measuring set-up.

Wedge magnet, secured to V block

Rotating coil read-out



Cooling fan for readout stand

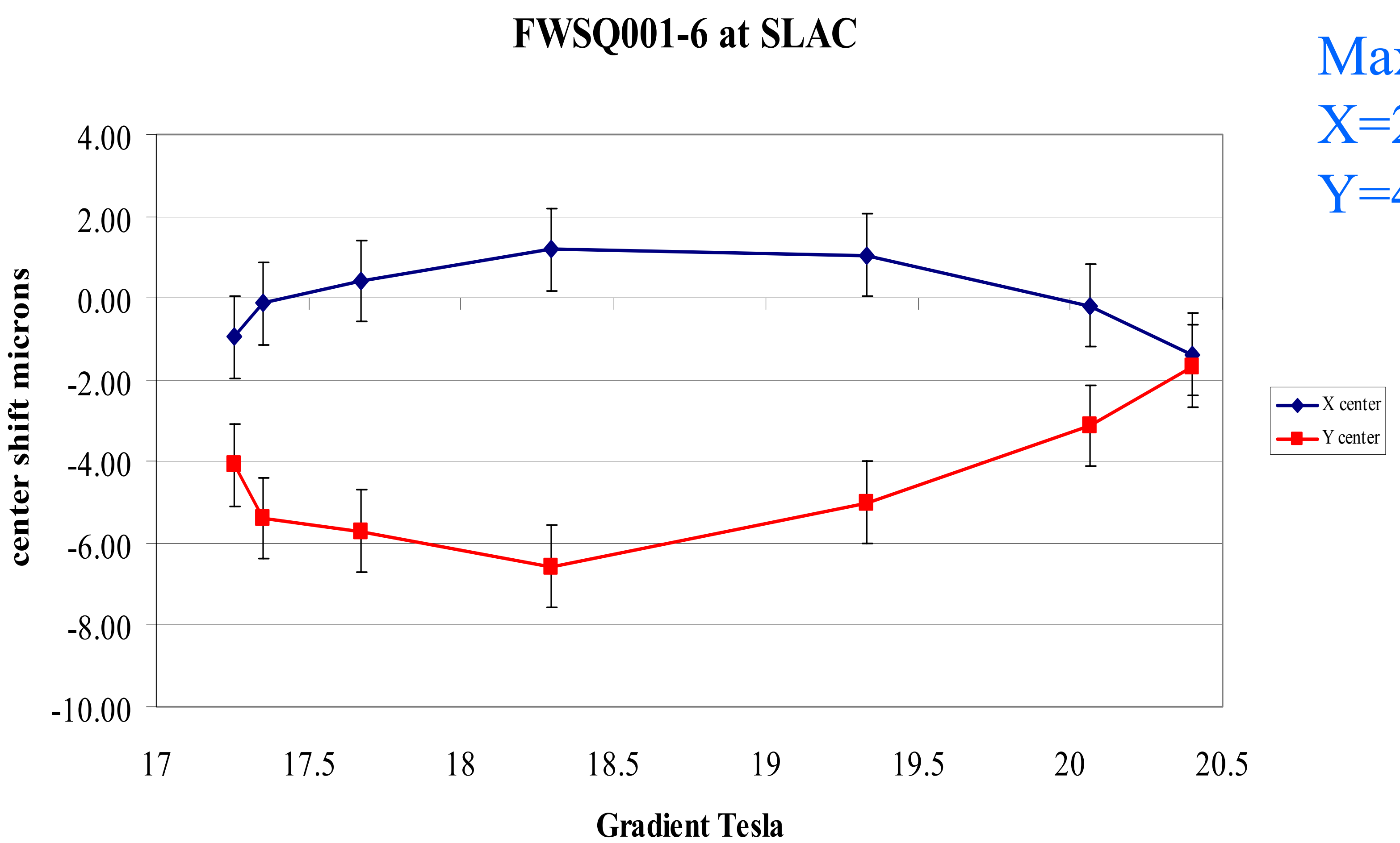
Aluminum V block, secured to granite table

Tuning rods rotation mechanism. One rod only connected. Smaller gear wheel turned with wrench.

Heidenhain 0.5μm indicator

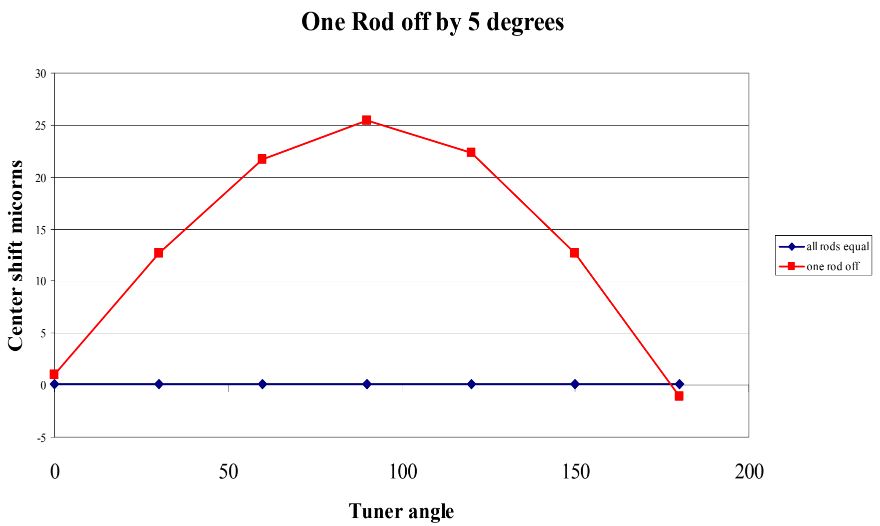
James T Volk

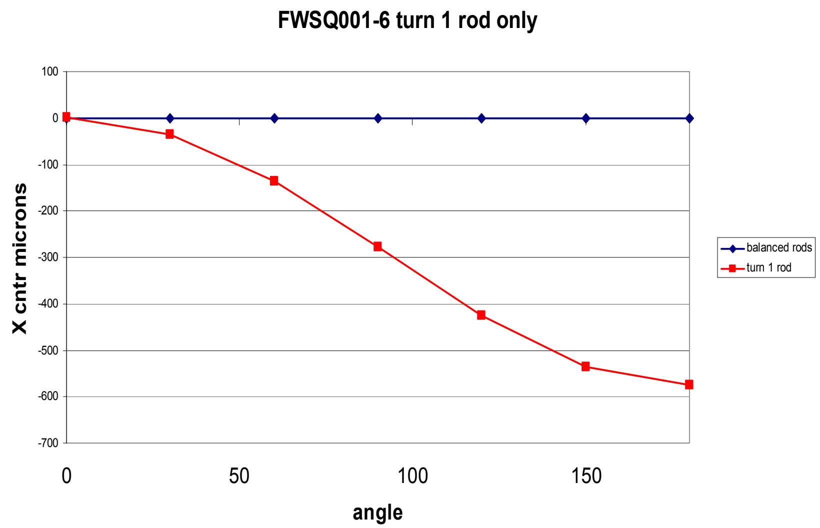
SLAC Rotating Coil Data

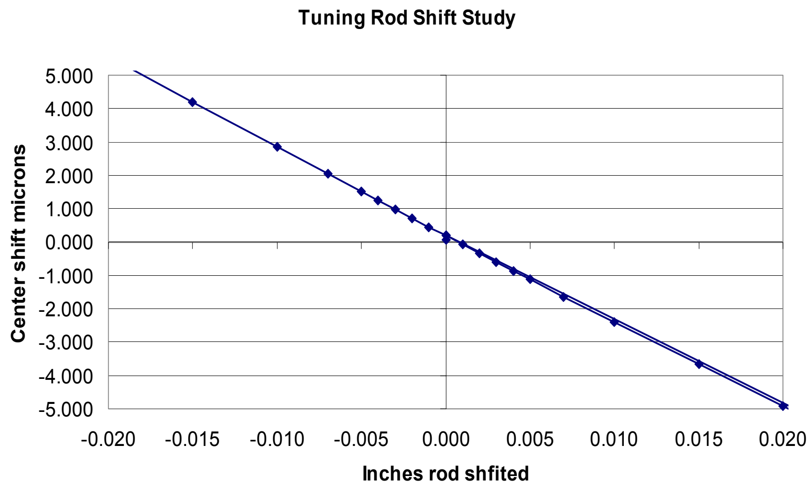


Max-Min
X=2.6
Y=4.9 µm

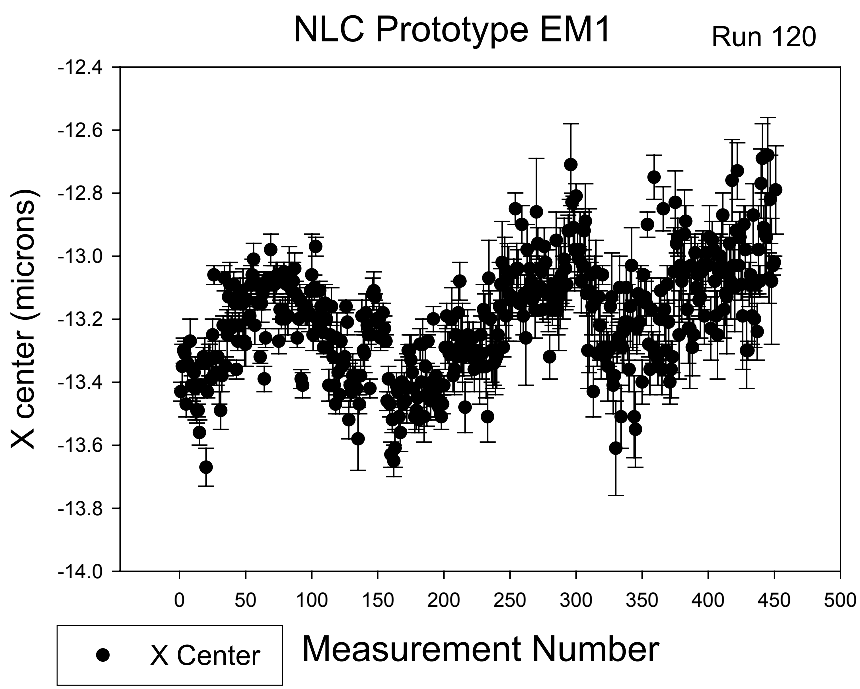
Studies Using Pandira

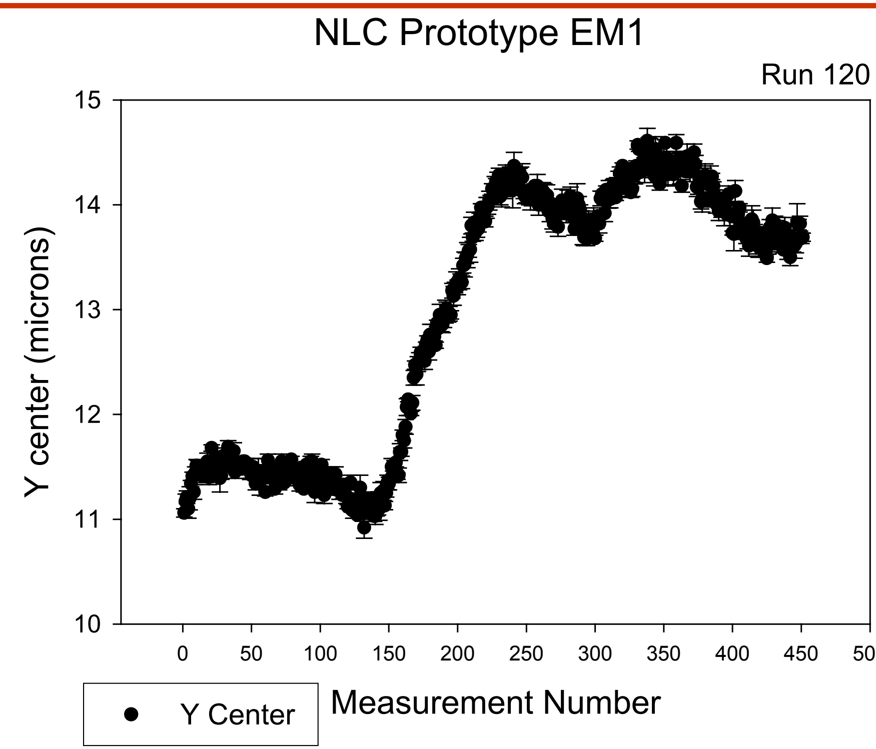






Electromagnet LINAC quad magnetic center measurements during 2.5 day run





X and Y centers measured with improved rotating coil setup, each data point took 8 mins.

X varies by < 1µm. Y has unexpected increase of ~3 µm over 10 hr period. Y values very sensitive to various apparatus temperatures, typically the magnet core steel.

Further Tests

- Using rotating coil to find true minimum value for each rod
- Make new rods so we can attach potentiometers and get angle read out of rods
- Re-work wedge quad to allow for tuning of pole strength
- Continue water flow studies and low field studies on EM quad

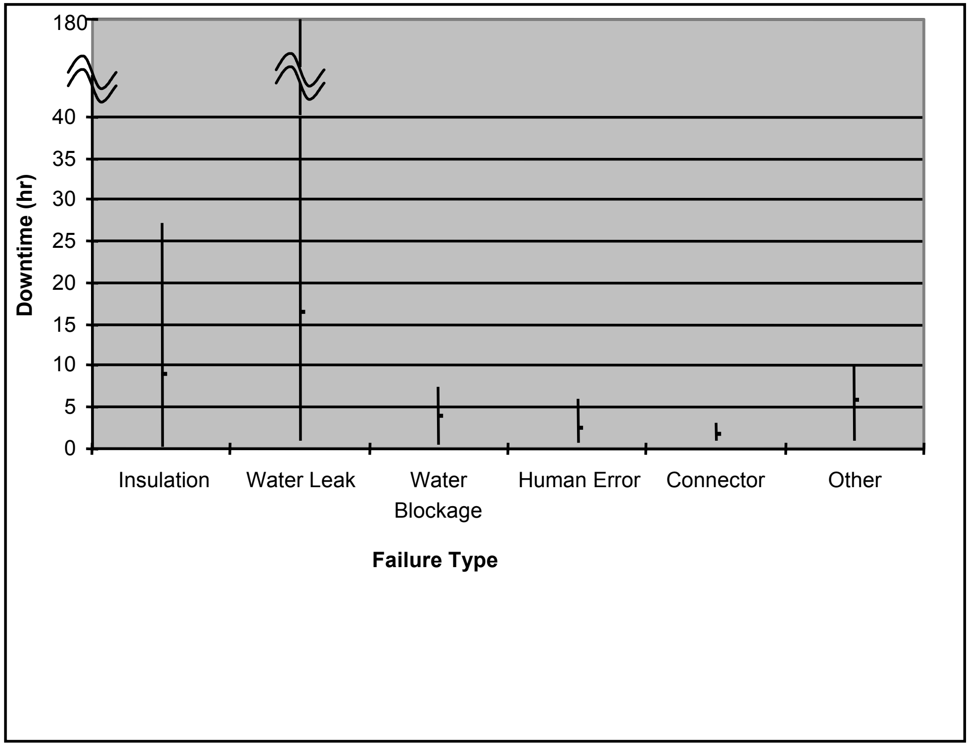
PM vs EM cost for Construction, Installation and Operation

- SLAC and Stanford engineering school working methodologies for cost estimation and reliability calculations.
- Still plenty of time between now ‘04 to explore and refine designs

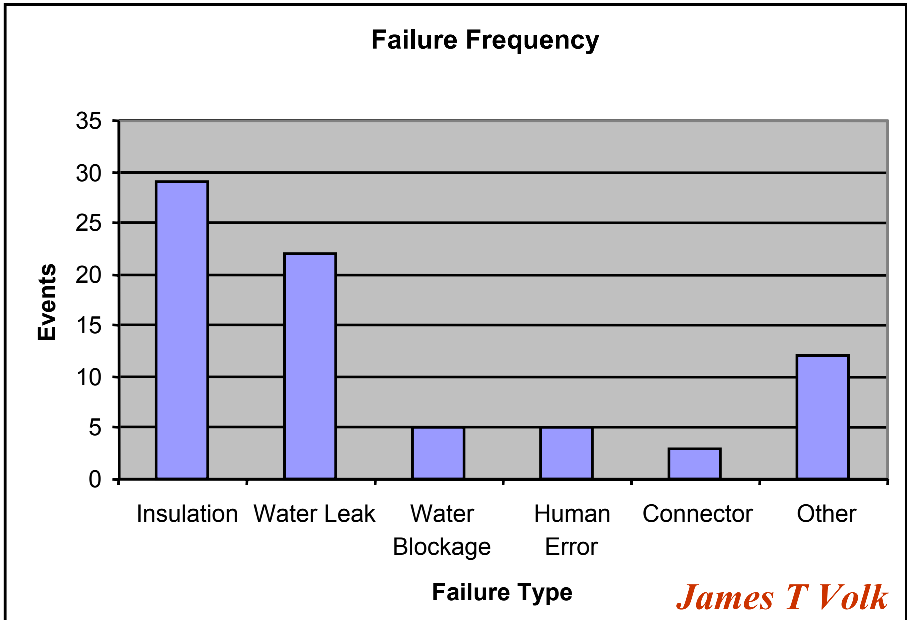
Developing Methodologies to Estimate Overall Magnet Costs- including repair costs

- Use real failure data of magnets to predict how often there will be failures of the magnets in the NLC. Estimate for a particular failure scenario how much it will cost to fix the failure– accounting for all aspects of the repair and the lost opportunity costs
- For real failure data: took all the magnet failures that brought down any beamline in SLAC during 5 year period. Using downtime reporting database we scrutinized failures as to its cause, type of magnet, length of time to detect and repair.
- Calculated mean time between failures.
- Calculate availability values and extrapolate them to known number of NLC magnets running for 30 years. Estimate cost to fix all failures.

SLAC Downtime by Failure Type



	Events	Min	Max	Avg
Insulation	29	0.2	27.2	8.82
Water Leak	22	1	180	16.44
Water Blockage	5	0.5	7.5	3.92
Human Error	5	0.7	6	2.5
Connector	3	1	3.2	1.733
Other	12	0.9	10.2	5.8



LBNL & SLAC work on designing magnets (PMs and EMs) for the damping rings

- Main Damping Ring lattices have been published with detailed requirements on all magnets
- Have 2-D model of DR quadrupoles and transport line dipoles. The Nd Iron style magnets are of reasonable size
- Investigated the Nd Iron quads, with rotating rods to generate the +/-10% adjustability, in more detail to see if they could meet all the requirements.
- Jin-Young Jung (LBNL) used TOSCA to make a 3-D model of damping ring magnets
- Validated the new 3-D model of the Neo quad by simulating it as an infinitely long magnet similar to the PANDIRA code. Poletip fields predicted by the 2 codes agreed to within 0.2%, so TOSCA model good.

Results from 3-D model of PM DR quad

- DR magnets have to have a "C" shape
  - allow for the extra wide vacuum chamber to extend towards the outer edge of the ring and be
  - capable of accepting the high amounts of synchrotron radiation.
- The TOSCA 3-D model of a 2cm radius Neo quad was run with a 25 cm effective length. The poletip field was 10% less than in the 2-D PANDIRA model.
  - Decrease due to flux loss
  - End Plates do not help reduce this

Final Focus Magnet

US Collaboration Meeting, May 7-8, 2002 at FNAL: Magnets Working Group

BROOKHAVEN NATIONAL LABORATORY
Superconducting Magnet Division
NLC - The Next Linear Collider Project

NLC Superconducting Final Focus Magnets

presented by Brett Parker for the BNL Superconducting Magnet Division

Present a design option for a small aperture superconducting magnet that meets NCL final focus gradient and space requirements and could be made using existing technology used for the HERA luminosity upgrade IR magnets.

Main challenge is not so much in making such a magnet but to work out impact of the stringent NLC final focus vibration requirements. Need very close interaction with the vibration working group.

Final Focus Magnet

NLC Superconducting FF Magnets – Closing Thoughts.

BROOKHAVEN NATIONAL LABORATORY
Superconducting Magnet Division
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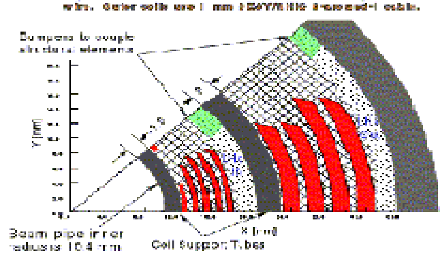
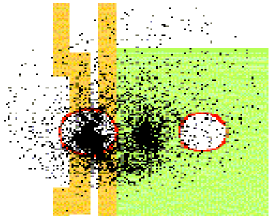
We have a preliminary design concept which we believe can be built with existing technology.

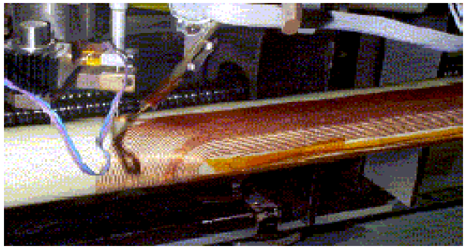


- Gives desired gradient.
- Fits in available space.
- Also has sextupole coil.



- Must check energy deposition assumptions.
- Work out solenoid details & magnet interaction.
- Figure out how to proceed on vibration issues.

Maybe we can construct magnet prototype in two years ($).
But how to stabilize it?
And how to test it?



Conclusions

- Slow but steady progress being made on LINAC quads
- We are quantifying the radiation fields in the Main Linac and Damping Rings
- First tests of radiation hardness are underway more ready to begin
- Working on Cost estimates and Failure Mode Analysis
- Working on magnets for Damping Rings
- Looking at magnets for final focus